ILLINOIS TECHNOGRAPH

MARCH
1942

★

Strategic Metal

Submarines

EE Show 1942

Betatron Research

Fluorescent Lighting

Names in the News

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Left: Oil circuit breakers and transformers at Boulder Dam Power Plant exemplify electrical engineering progress.

shed 1885 Member E.C.M.A.

20¢

The heat treatment that contradicted itself

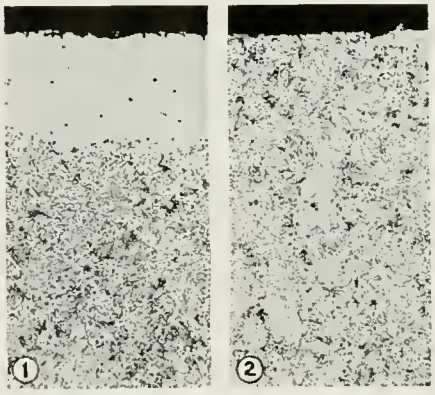
How Westinghouse Engineers straightened out a paradox in steel

METALLURGISTS have been heat-treating steel for 2,500 years. They've taken steel parts, subjected them to heat, cooled them quickly by quenching them in water, oil, or gas, and so hardened them.

But the heat treatment contradicted itself.

For while they were heat-treating the steel to harden it . . . they also softened it. As the steel was being heat-treated, oxygen combined with the surface carbon, decarburized and softened the surface.

Naturally, metallurgists had to remove this softened surface. They had to pickle, grind, or machine the surface—processes



This photomicrograph of SAE-6150 Spring Steel shows .005" decarburization with ordinary scale-free atmosphere.

This photomicrograph of SAE-6150 Spring Steel shows no decarburization with Endogas atmosphere.

which not only wasted time and cost money but also accounted for a whole lot of inefficiency.

The dimensions of many steel parts, especially dies, have to be accurate to a few thousandths of an inch. So, metallurgists had to make the steel parts larger to start with, just enough larger so that they'd be the right size after the softened surface had been removed. And that left room for plenty of mistakes.

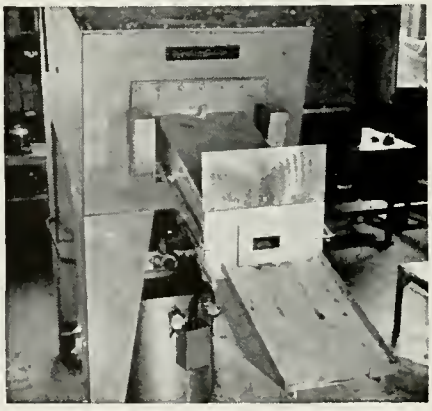
▸ Something, Westinghouse engineers decided, should be done to get rid of all this heat-treating trouble.

They figured the thing to do was to find a way to keep carbon-hungry oxygen from getting at the steel surface. And that was the thing they did.

First, they settled on using an electric furnace since it would give them accurate temperature control and entirely eliminate gas fumes. Then, they created a special atmosphere for the furnace. They heated ammonia (NH_3) in the presence of a catalyst and separated it into its component parts, nitrogen and hydrogen. The nitrogen is inert and won't combine with anything. The hydrogen, in the absence of oxygen and water vapor, also refuses to have anything to do with the carbon.

In this special atmosphere, which Westinghouse engineers called Ammogas, steel parts could be treated with electric heat and . . . no softening of the outer surface took place, no time-wasting, inefficient finishing had to be done. The dies and other steel parts came out of their heat treatment bright, shiny, all ready to use.

▸ The Ammogas furnace that Westinghouse engineers created took care of the heat-treating of costly parts like dies, which can be gas-hardened and are not produced in great quantities. But Ammogas is expensive—too expensive for



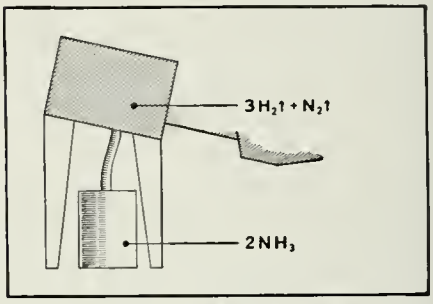
Here is an Ammogas Furnace.

the ordinary heat-treating of thousands of machine parts. And it is not suitable for heat-treatments requiring high temperatures.

So Westinghouse engineers developed Endogas—a special atmosphere which would do large-quantity, high-temperature heat-treating jobs, and do them at low cost. They heated ordinary gas (natural or manufactured city gas is all right) and, by a special but inexpensive process, changed it into a gas rich in hydrogen and carbon monoxide and containing a little water vapor and carbon dioxide.

Endogas doesn't do its work by *avoiding* all decarburizing agents, carbon dioxide and water vapor; it *overpowers* them by the inclusion of agents like carbon monoxide and methane that work in the opposite direction.

In effect, Endogas maintains a balance between carburizing and decarburizing forces. This balance can be so closely controlled that it is even possible to *add*



A diagram of the Ammogas furnace.

carbon to the steel that's being heat-treated.

Today, the Ammogas and Endogas furnaces are hard at work heat-treating dies, castings, airplane parts, steel parts of all kinds, helping to turn them out faster and better—saving industry time, money, and mistakes—speeding crucial war production.

★ ★ ★

There is one reason why Westinghouse was able to create controlled atmosphere furnaces and lick decarburization. It is because Westinghouse is an engineer's company.

There are 3,500 engineers in Westinghouse . . . in service, in sales, in design, in research, in management, in every branch of the business. Engineers hold key positions in each of the 17 Divisions of the Westinghouse Company.

Engineers determine our ability to find better ways to get jobs done. Engineers direct the creation and manufacture of our products. Upon engineers our success depends.

Behind our training and our encouragement of individual effort, there is a definite purpose. Behind our organization set-up of many divisions, which are like small companies within a company, there is a definite purpose. That purpose is to develop young engineers like you into the kind of engineers who will take good care of our future.

Westinghouse

"An Engineer's Company," Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

MARCH ★ 1942

Electrical Show Issue . . .

THE TECHNOGRAPH

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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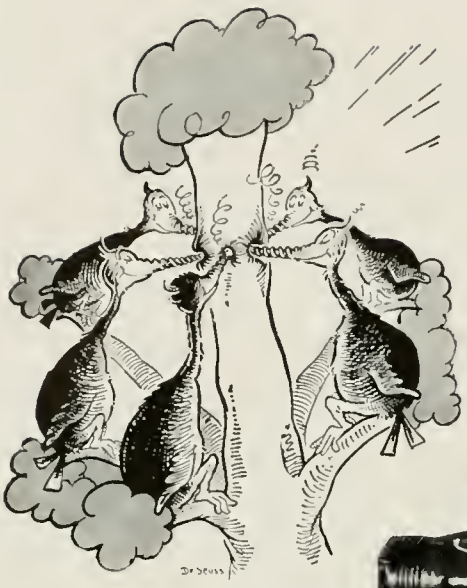
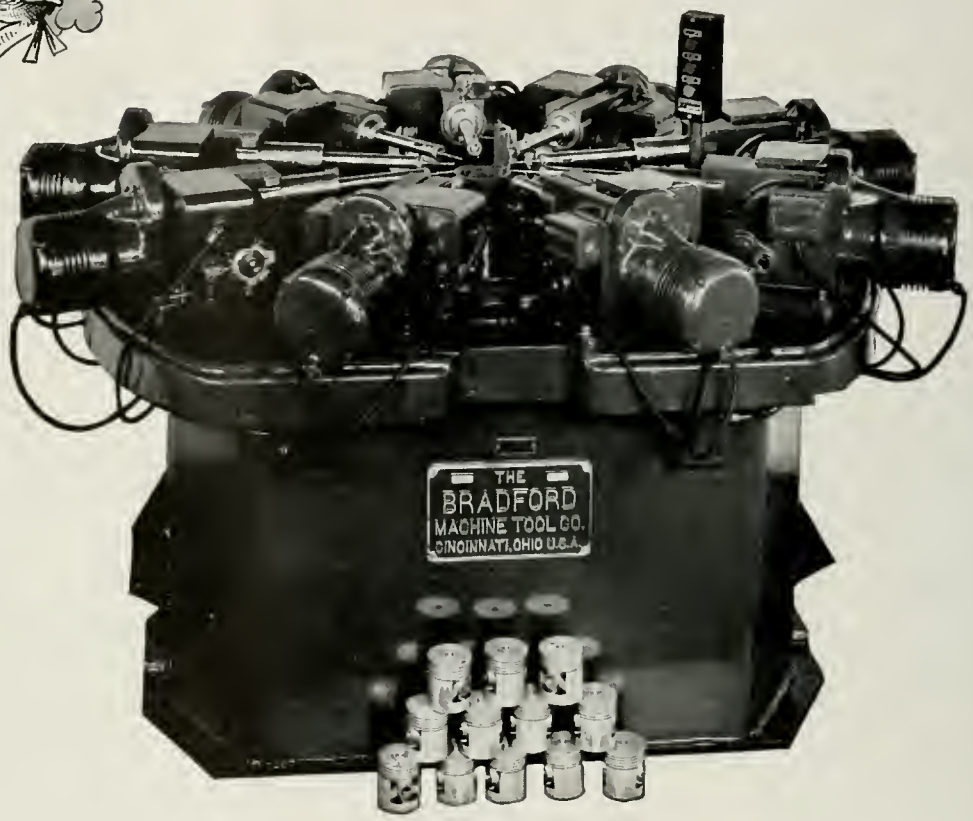


The Sapjap Calls It Heaven

He sits all day, drilling the beautiful wood. He has lots of time. Holes won't be spaced right, but he doesn't care. He thinks it's champagne—the sap.

How different his neighbor below. It has work to do—fast, accurate, continuous work. 10,800 holes per hour, 14,400 pistons per day. No time to adjust or fuss with bearings.



America Demands Speed . . .

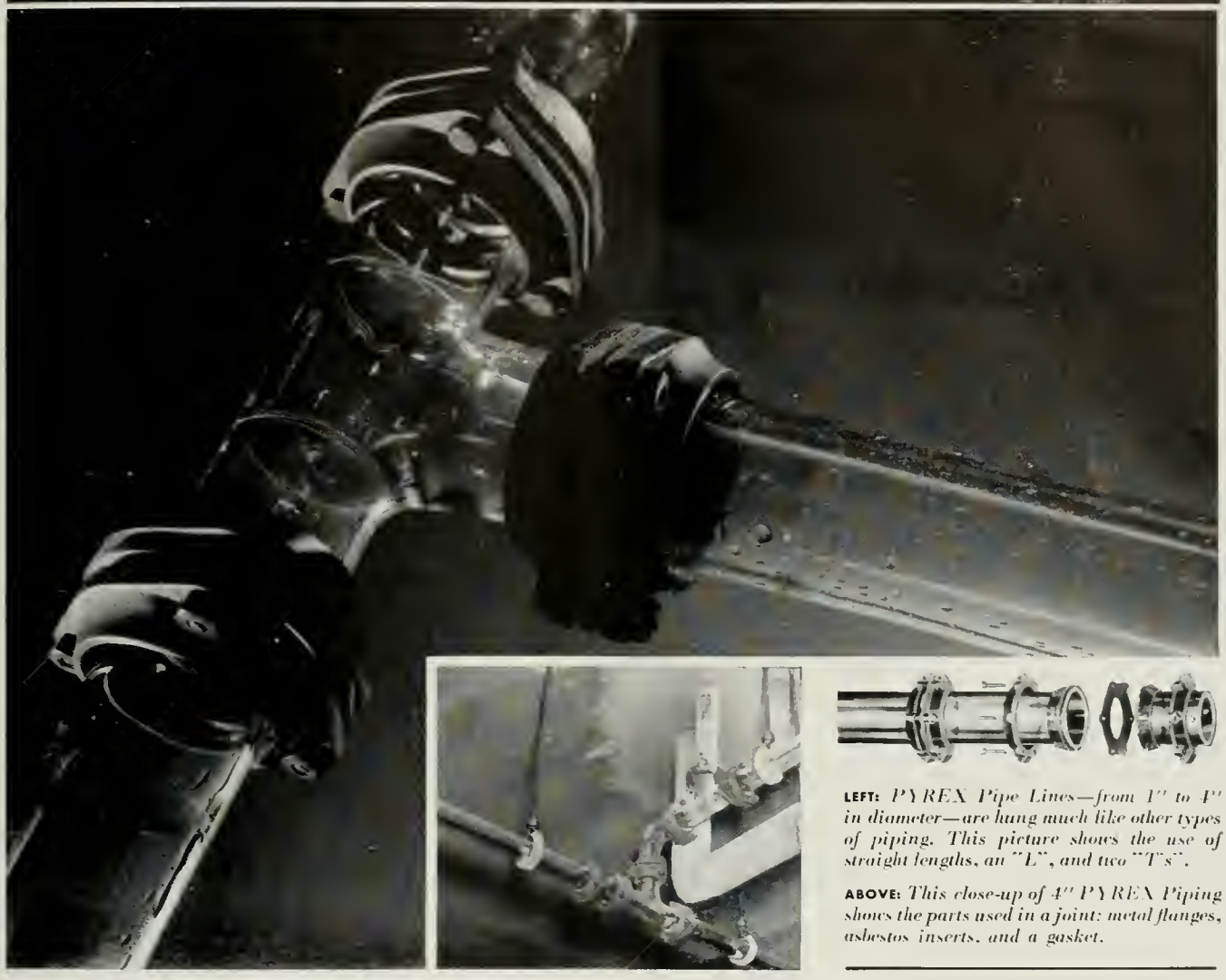
and gets it in this 9-spindle Bradford Drilling Machine. 92 New Departure ball bearings support its rapid fire spindles and other vital parts. 92 positions where accuracy and rigidity are permanently assured. It's no Sapjap.

. . . **Engineers Only:** A special bearing requires extra tooling and different machine set-ups—delays the delivery of many standard bearings. To speed war production, consult a New Departure engineer as to availability of bearing types and sizes. Do this when your design is still "on the board." New Departure, Division of General Motors, Bristol, Conn. Detroit, Chicago, San Francisco.

New Departure

THE FORGED STEEL BEARING 3078

The pipe that can't keep a secret...



LEFT: *PYREX Pipe Lines—from 1" to 4" in diameter—are hung much like other types of piping. This picture shows the use of straight lengths, an "L", and two "T's".*

ABOVE: *This close-up of 4" PYREX Piping shows the parts used in a joint: metal flanges, asbestos inserts, and a gasket.*

THIS ginger ale maker is as finicky as a New England housewife. (Probably why his ginger ale is an Eastern best-seller.)

"I want pipe I can see through", he said, "so I know it's clean. Pipe that can't alter the flavor of my product any more than the glass bottles it is sold in. Darn it, I want glass pipe!"

Glass pipe lines, made by Corning, are a familiar sight in food, beverage, and chemical plants . . . paper mills, refineries, explosives factories . . . drug, medicine, and cosmetic plants . . . in short, wherever product purity is vital.

Highly resistant to corrosion attack, Corning's PYREX Piping eliminates this cause of contamination. Transparent, it keeps no secrets . . . a glance tells of flow, cleanliness, color, sedimentation. And freedom from pitting and scaling means long life for these pipe lines, with low maintenance costs.

Important? Yes. For in today's urgent program there's no place for impure products, production stoppage, high maintenance costs, or wasted materials. And in many instances, glass has proved it can outperform metals, do an essential job better and at a lower cost.

To the engineer, this glass piping is important as an example of the many-sidedness of glass in industry and of Corning research in glass . . . research that takes in its stride such divergent tasks as the making of a tiny chemical-resistant glass spring, smaller than your thumb, or the casting of the world's largest telescope mirror, a giant one-piece disc 20 tons in weight. Today more than ever Corning is headquarters for research in glass. Industrial Division, Corning Glass Works, Corning, New York.

CORNING
means
Research in Glass

MAGNESIUM ★ *from the sea . . .*

By August Uttich

Freshman in Chemical Engineering

Near the spot where Stanford University students do their daily labors, close to the present key city of San Francisco, a new plant has been erected; and late in August it started commercial production of ingot magnesium. In Palo Alto, California, the Permaneate Corporation has opened the second plant in the United States for the production of this metal, proving that it is possible and profitable to produce it by the reduction of the ore with carbon.

As an alloy, magnesium is most largely used in the manufacture of airplanes. A single airplane, on the average, uses 985 pounds of magnesium in its construction. Crankcases, oil pans, pistons, landing and tail wheels, cockpit fittings, door frames and housings are ideal parts of the planes on which to reduce weight by the use of light magnesium alloys. One hundred pounds, it is estimated, can be saved by using magnesium instead of aluminum in the five foot landing gears of some planes.

Though these uses seem most important in the present emergency, and are, indeed, most important, they are by no means the only commercial uses for the metal. Parts of cameras, golf club heads, parts of typewriters, and artificial limbs all employ, in their manufcaure, alloys of magnesium. It is a deoxidizer in metallurgy. It is extremely valuable in flash bulbs and in flash powders. From this can be seen its apparent use in incendary bombs and flares.

After the war in 1918 two companies were producing magnesium commercially. The American Magnesium Corporation, however, discontinued and turned to manufacturing magnesium alloys and fabricating alone. This left the Dow Chemical Company the sole producers of ingot magnesium. Their process, the Dow Process, is essentially electrolytic.

By taking advantage of differences in solubilities, a relatively pure magnesium chloride salt can be obtained by crystallization of brine taken from the sea, and sometimes prepared from salt deposits. The impurities, magnesium hydrate and calcium chloride, are removed by a carbonating process which concentrates the magnesium chloride and leaves a chalk waste. From the magnesium chloride crystals, the water of hydration must be removed. Five parts of this can be driven off by gentle heating, but the persistent sixth requires a dry hydrogen chloride gas stream to pry it loose from the compound. Fused magnesium chloride is then electrolyzed to obtain 99.95% pure magnesium and chlorine, which is likewise an invaluable product, especially in wartime.

The method used by the American Magnesium Corporation during the last war, called the oxide or fluoride process, was likewise electrolytic. Magnesite ores were calcined, the oxide was fused, and to it was added barium fluoride to make the bath more fluid and a very small amount of sodium fluoride to conduct the current. When the current was passed through the bath molten magnesium and oxygen were obtained. The chief difficulty in using this procedure was the low solubility of the magnesium oxide (0.1%). In addition, a half pound of carbon anode was consumed for each pound of resulting magnesium.

Dr. Fritz Hansgirg over twelve years ago originated a process for the production of ingot magnesium by reduction with carbon. The Austro-American Magnesite Company has been experimenting with this inexpensive method and has for some time had a commercial plant in Radenthein, Austria, and recently, in England and Korea. It was Dr. Hansgirg who supervised the building of the Permaneate plant at Palo Alto, which began last March by certificate of the Office of Production Management.

In this process, magnesite ores, which will at first be taken from Luning, Nevada, deposits (41.6% Mg.) must be calcined as in the fluoride process. Anthracite, coke, or charcoal are mixed with the magnesia in their ratio of combination according to the equation:

$$MgO + C = Mg + CO$$

The mixture is finely ground, mixed with a tarry substance and pressed into blocks. When these blocks are placed between the electrodes of an electric furnace at 2100°C and the electric current passed, the carbon reduces the magnesium according to the above equation.

Magnesium vapor and carbon monoxide leave the furnace at a temperature of 2000°C. If allowed to cool normally, a reaction the reverse of that above takes place, reoxidizing a great part of the metal. But according to the process outlined by Dr. Hansgirg, a gas, neutral to magnesium, is introduced to "shock chill" the mixture, taking the carbon monoxide by surprise, so to speak, before it can recombine with the metal. The powdered magnesium dust obtained is filtered through wool bags.

Yet, the engineering is not complete. The dust is only from sixty to sixty-five percent pure. The powder must now be pressed and distilled. For this distillation, vacuum retorts have been devised since hot magnesium burns violently in oxygen and air. Crystals of distillate are at last melted and cast into ingots.

The residue from the vacuum retorts, which is nothing but recombined magnesia and carbon, is again briquetted so that no waste occurs there. The "chilling gas" is often hydrogen. In this case, the monoxide can be removed through action with steam and lime. In the Permaneate plant, natural gas is being employed, which, after its use in "chilling," is led as water gas to the nearby cement mill to be burned as a fuel. It requires over twenty volumes of "chilling gas" to lower one volume of the magnesium vapor and monoxide to the necessary 200°C. The gas can be used over without repair till a 7 or 8% CO concentration is reached. The power required is only 22000 kilowatt hours per ton of metal.

The only difficulties of this procedure are the dangers in handling the explosive magnesium powder and the equally explosive hydrogen or natural gas. It seems, however, that under the direction of Dr. Hansgirg these difficulties have been overcome.

In a government sponsored test plant in Pullman, Washington, revisions of the Hansgirg method are being tried. Most important of these is the use of oil pressure to chill the gaseous mixture. This eliminates danger from an explosive gas and since the oil absorbs the magnesium dust and forms a film around the exit of the products, greatly reduces the danger from the metal itself.

The production of magnesium is a growing industry that will be important in war or in peace. And the new Hansgirg method, quick and inexpensive, is another triumph for science and engineering.

FRONTISPIECE:

TVA's PICKWICK DAM will produce an additional 36 million watts of electric power for defense industries when this generator shaft flange turns. John Kelcker, veteran machinist, is shown making the bore for the governor which maintains the speed of the 45 ton shaft at 81.8 revs. per minute. (Cut courtesy of Westinghouse).

Bigger Future Seen for

SUBMARINES ★

of the United States Navy

Although the inception of the submarine boat dates back to the seventeenth century, it was not until three hundred years later that practical development was begun. The rapid development that has since taken place is realized by results of its use in the first World War and in the present conflict.

In 1900 the U. S. Navy added its first submarine. The ship was torpedo shaped, had a length of 53 feet, a beam of 10 feet, and a 74 ton displacement.

DEVELOPMENT OF SUBMARINE

Many varied engineering problems were yet to be solved, however, before the submarine could be effectively used as an implement of war. The distribution of weight, for example, is of prime importance for, unlike a surface vessel, the submarine has a comparatively small reserve buoyance. It is suspended like a balance scale and must be in equilibrium in a horizontal position. The balancing moments about this point must be gained as far as possible by the distribution of all machinery, equipment, and fixed articles because the displacement limitations allow only a relatively small weight of permanent ballast to be utilized, and can be of but little assistance in effecting the trim. The laws of submarine navigation demand that the center of gravity and the center of buoyancy be kept as far apart as possible.

Speed and power estimation is a second engineering problem of great importance. In estimating the speed and power required for the propulsion of a certain proposed design, there are three factors which determine propulsive efficiency: engine efficiency, propeller efficiency, and hull efficiency. The propulsive efficiency is the ratio between the E. H. P. (or two-rope Horse Power) and the I. H. P. taken at the cylinders of the engine. In actual practice, this value ranges from 42 to 62 per cent of the I. H. P. The final verdict as to the actual efficiency is based on a chart of speed and power curves which must be drawn up to accompany each new design.

The first practical means of motive power installed in a submarine was the steam engine, but this was found to be of little use in such an application. Internal combustion engines solved the problem to some extent, but obviously these could not be used for submerged locomotion.

ELECTRICAL POWER PLANTS

Although the ideal form of power plant for the submarine is one that is capable of operation both when the submarine is on the surface and when submerged, so far as is now known no such system has yet been devised. At the present time the submarine is equipped with a Diesel engine for surface operation and with a direct current motor for use below water levels. The preent motors are ruggedly built, have their armatures mounted on the main shafting of the engines, and are well insulated. They are interpolar, D. C. ventilated type, capable of running in either direction under great variations in load. They are often operated at an overload of as much as 90 per cent without injurious heating. A potential difference of about 70 volts is allowed at the field terminals to provide for speed regulation when running as a motor and for adjustment of voltage when operating as a generator. When the Diesel engine drives the motor as a generator, storage batteries of the "Lead Cell" or of the "Edison" type are charged. Neither type of battery may be called ideal for this use, though rather efficient operation is secured by the use of either.

The problem of navigation for some time was of great consequence in the effective use of submarines. Until the advent of the gyroscopic compass, navigation was more or less a combination of dead reckoning and luck, for the hull is constructed of magnetic material and large electrical currents flow throughout the ship constantly during operation, the variations of the needle of an ordinary magnetic compass rendered it useless in submarine navigation. Attempts were made to overcome these difficulties by mounting the compass outside the ship in a composition helmet, but all attempts of such a nature proved fruitless, and were finally given up with the invention of the gyroscopic compass. Navigation worries were over.

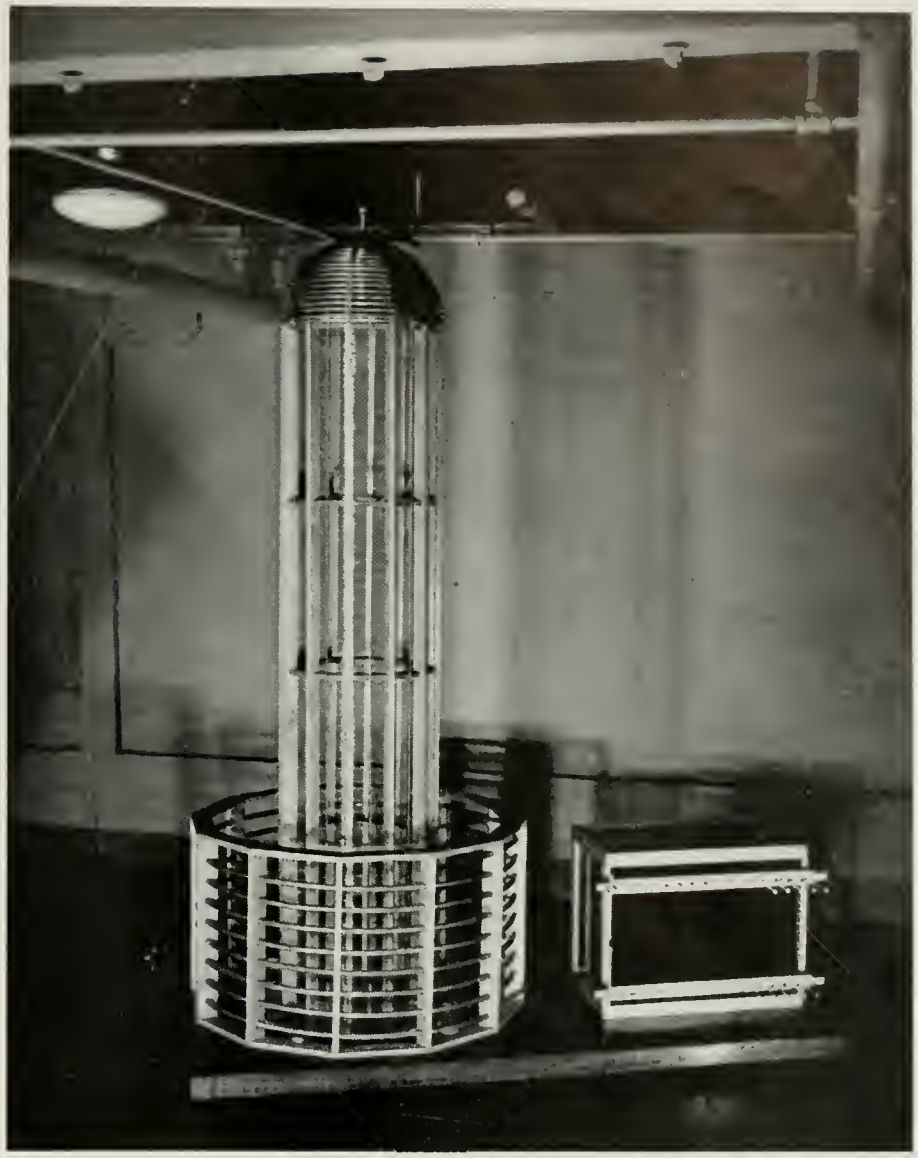
The advance in communication systems and signaling devices has kept pace with the rapid improvement made in other submarine equipment. For surface navigation, the submarine is equipped with practically the same signaling devices as any other shipflags, sirens, bells, and lights. For outside communication, a wireless sending and receiving set is among the usual equipment. But here too, engineers have yet to solve some problems, for at the present time the radio can be used only when the boat is on the surface of the water. It is now necessary to break all electrical connections on the outside of the hull and close a watertight joint before going under water. No wireless messages can then be sent or received until the submarine returns to the surface and the radio is literally reinstalled on the ship's deck.

UNDERSEA LIVING

Perhaps the factor which should be considered as secondary only to efficiency and safety is habitability. At its best, service on a submarine is almost "a dog's life." The physical endurance of the crew is one of the chief factors which now limit the radius of action of a submarine; hence every possible effort should be and is being made for the crew's comfort. Comfortable berths, dry lockers for storing clothing, wide decks for fair weather cruising, and an efficient heating plant all make for this end. An electric range and ice box are among other items which make for the contentment on the part of the crew.

Looking to the use, past and present, of the submarine in the present conflict, we arrive at a safe and sane conservative deduction as to what the future development of the submarine will bring about. Certainly the goals to be attained are evident: a roomier craft to provide for a less cramped crew's quarters; a new power plant which will operate both above and below the surface of the sea; a new development in radio which will provide outside communication during the time of submersion; an increase in surface speeds and cruising range; further improvements in mine laying apparatus, cable cutting devices, and more efficient means for the rapid handling of torpedoes.

Engineering must march onward with America to victory!



Right: Giant Telsa Coil, one of the larger exhibits at the Electrical show.

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Programs

1942 ELECTRICAL SHOW

FEATURES VICTORY PROGRAM April 9, 10, 11

Every two years our campus is stirred by the approach of a most singular attraction. Emotions run high and amid the wondering and anticipation young lovers substitute for their usual topics of conversation prolonged discussions about this forthcoming event. "What," you may well ask, "can this awe-inspiring thing be?" "A personal appearance of Gypsy Rose Lee? the 'Dance of the Seven Veils'?" No, the big event is the 1942 ELECTRICAL SHOW!

Maintaining their reputation built up in years past, students of the Electrical Engineering and Engineering Physics departments have planned a show which is both entertaining and instructive. For those of scientific bent, there will be such exhibitions as the high-voltage Tesla Coil, capable of producing 12-foot sparks; the "Floating Dishpan"; and many others. For those of less scientific tendencies, such attractions as the Kiss-O-Meter will be featured. The *use* of this interesting device we will leave to your imagination—only one guess needed!

It was suggested that in view of developments dating from December 7, last, we abandon plans for a show this year. It was decided, however, that a show this year could definitely contribute to the public morale by focusing the attentions of the public to the great advances on the front of Engineering. In keeping with the times, the underlying theme chosen for the 1942 show is "National Defense."

Many exhibits will this year be of a military nature, such as the radio-controlled tank, or perhaps a model of a magnetic mine now under construction. Other exhibits, while not of obvious military character, will suggest a definite military application. It is hoped an exhibit demonstrating the micro-wave phenomenon may be made. These ultra high frequency radio waves may be used for the detection of enemy airships and submarines far more effectively than any other medium. Obviously care must be made to not liberate military secrets by such an exhibition.

The dates for this year's show include April 9, 10, and 11. Circle these dates on your calendar and plan to attend. The combined efforts of the Engineering Physics and Electrical Engineering departments will guarantee you'll never regret it!

Professor Kerst's

BETATRON

New Electronic Developement

By Robert E. McCleary
Junior in Mechanical Engineering

★

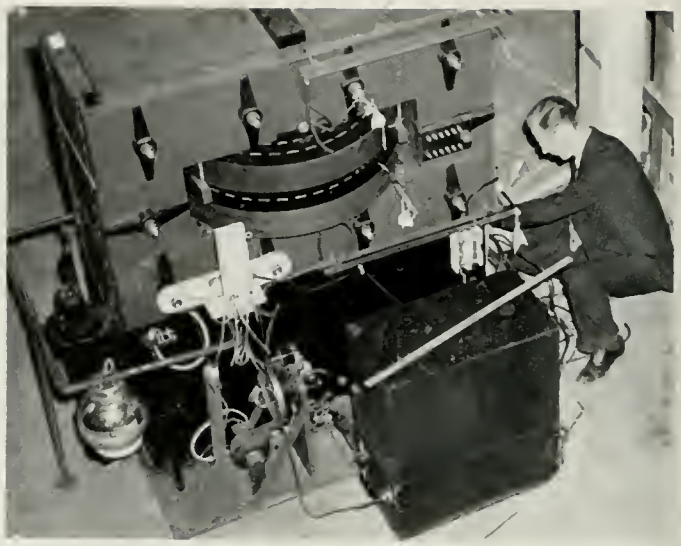
Tall, young, Professor Donald Kerst of the University of Illinois Physics Department has just completed the installation of a machine which develops the most powerful X-ray in the world, and has many important possibilities in industry, medicine and atomic research.

It is called "The most important invention of a decade in the field of atomic physics," by President Arthur Cutts Willard, head of the University of Illinois and himself a noted engineer.

The name Beta-tron is a combination of words. Beta refers to the electrons, or Beta particles which are accelerated, and 'tron' is a Greek word meaning "agency for producing."

The machine is now installed in the new Abbot power plant, within a two-foot thick wall of concrete blocks to shield its penetrating rays. It is an induction electron accelerator, doing for the electron what the Cyclotron does for the positive ions. In it, electrons, the negatively charged, satelite particles of atoms are accelerated to a velocity of nearly that of light, 186,000 miles per second, the fastest ever attained by artificial means.

Closeup view of the "doughnut," heart of the Betatron.



Professor D. V. Kerst of University of Illinois with Betatron. General view.

A doughnut-shaped vacuum tube placed between the poles of a powerful magnet from the heart of this revolutionary device. Inside the tube, magnetically guided electrons are accelerated for 200 miles in a circular orbit, obtaining an energy of 20,000,000 volts before crashing into a tungsten target where X-rays of the same voltage are generated. The X-rays are equal in intensity to the gamma rays from 1000 grams of radium, more than the present world's extracted supply.

The machine weighs 4 tons, to the massive Cyclotron's 80 tons. Its electro-magnet is 5 feet long, 2 feet wide, and 3 feet high, and contains between its poles the doughnut tube whose outer diameter is 18 inches and whose inner diameter is 12 inches. A steady push of as much as 70 volts per revolution, speeds each electron on its dizzy journey.

The Cyclotron cannot accelerate electrons, and high velocity electron beams have not kept pace with experiments done on positive ions by that machine. Former machines have reached a practical limit of electron acceleration of 1 6 Dr. Kert's machine, or 3 million volts.

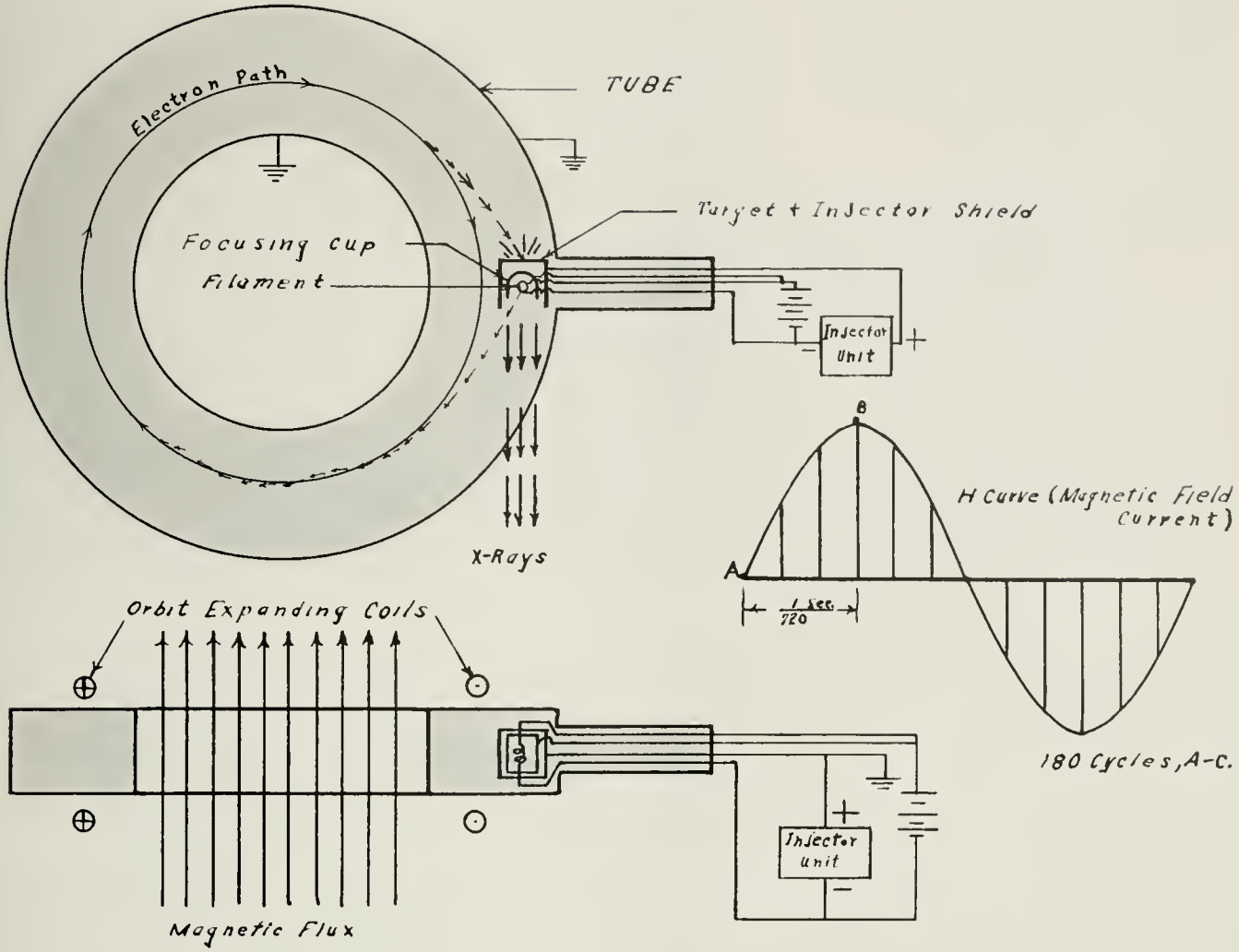
Furthermore, there seems to be no limit to the energy of the induction accelerator. Apparently its effective voltage can be increased indefinitely. Dr. Kerst directed his efforts toward the development of a 100 million volt accelator and spent the past year at the General Electric Research Laboratory, building his present intermediate 20 million volt Beta-tron.

It was while a bid was being solicited for the manufacture of the 100 million volt machine to be built for the University of Illinois that the Company confiscated his plans in order to make the machine for themselves.

Scientists here believe that such a machine may artificially produce Cosmic-ray phenomena. At present, journeys to lonely mountain tops are necessary for study of these mysterious rays from outer space. Perhaps a year's work on Cosmic rays could be accomplished in a day by a machine which produced Cosmic ray effects in the laboratory.

OPERATION . . .

In the purely diagramatic drawings on this page are seen the principle elements of the accelerating tube. At lower left is seen the magnetic flux which is produced in the laminated field magnets by the AC current from points A to B on the sine wave shown. About 20 watts are absorbed by the whirling electrons, which increase their masses



40 fold because of the relativity effect as they approach the speed of light.

All engineers who have taken physics will realize that if the doughnut tube contained loops of wire instead of whirling electrons, the changing magnetic flux would cause an E.M.F. of (f) $N \times 10^{-8}$ volts, where (f) was the flux, and N the number of turns of wire, to be induced in the loops.

This is the neucleus of the revolutionary idea for such high voltages and electron velocities as obtained in this machine. Actually the loops of wire (corresponding to the secondary of a transformer coil) are replaced by electrons which circle 450,000 times, the equivalent of the same number of turns of wire, with a 70 volt peak per revolution.

The hot filament glows continuously and electrons are injected into the doughnut by sudden application of a potential difference between the filament and the injector shield. This voltage is applied briefly at time A, approximately. After injection, electrons are caught and started on their dizzy trips. Dotted lines show how the electrons are curves toward the normal orbit and wavers from side to side before finally settling down to whirl 450,000 times about the tube in the time the current has changed from A to B, 1-720 second.

An additional surge of flux through the center of the orbit, when magnetic field has reached peak value, B, expands the orbit outwardly, causing the electrons to impinge upon back of injection structure, which acts as a target.

This tungsten target so bombarded, emits powerful X-rays in a strong concentrated, directional beam, as shown. As soon as the current wave has traveled 2 Π or 1-180 second, the same cycle repeats itself. Electrons are whirled one way, only. The tube waalls are 1-4 inch thick and its silvered inside surfaces are grounded. Occasionally a stray molecule of gas is struck by the whirling electrons and X-rays may be emitted in any direction, right through the walls of glass.

The X-rays have been shown able to convert copper to its radioactive isentrope which then decays to nickel. In principle, every element known is susceptible to this transmutating effect.

Professor Kerst was born in Galena, Illinois, and later lived in Wauwatosa, Wisconsin. There, while helping a neighbor build an amateur radio station, he became interested in science. He attended the University of Wisconsin, where he received his AB. degree in 1934 and his Phd. degree in 1937. He is an honored member of Phi Beta Kappa, Sigma Xi, and Gamma Alpha.

At Wisconsin, he did research work with Dr. Raymond Herb and Dr. David B. Parkinson with pressure electrostatic machines. This work attracted attention in scientific circles, and led several institutions to construct similar machines for neuclear research.

Then Professor Kerst worked for a year on X-ray tubes in the General Electric X-ray Corporation laboratory in Chicago. In 1938, he came to the University of Illinois, where he built the first electron accelerator, a table-top size machine of 2 and 1/2 million volt energy.

Much more will undoubtedly be heard of the Beta-tron, for research with it has scarcely begun. The University may be justly proud to have on the faculty such a distinguished and competent a genius as Professor Kerst.

Fluorescent Lighting

Modern Illumination

★

By Hayward L. Talley
Freshman in Electrical Engineering

(Illustrations courtesy General Electric Company.)

In war indstries, fluorescent lighting is helpng to speed up production. Here a welder is "doing his part" on the night shift in an airplane factory.

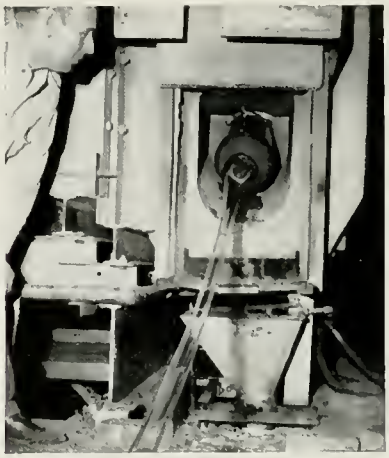
Shedding an abundance of pleasing light over the drawing board, the office desk, the drill, the lathe, and the kitchen table, is a new type of lighting unit which has won the praise of the draftsman, stenographer, industrial worker, and homemaker alike. During 1941 alone over twenty-two billion fluorescent tubes were purchased by the American public.

Actually, fluorescent illumination is not as new as it would seem, for as early as 1570 a Spanish physician, Nicolo Monardes, noticed that when a tincture of a certain type of wood was illuminated it took on a blue color. Three centuries later the English physicist, Sir G. C. Stokes, determined the true nature of the phenomenon, and called it *fluorescence.*

About 1884, Edison discovered that if inside an exhausted incandescent electric lamp of the ordinary type, a third wire is introduced, insulated from the filament connections, and maintained at a voltage positive with respect to the filament, then a current would flow across the vacuum inside the tube from the third wire to the filament as long as the filament was incandescent, but that the current ceased as soon as the filament became cold. This phenomenon was called the *Edison Effect.*

These facts established by Stokes and Edison are the elementary foundation upon which modern flouroscent lighting is based. In contrast to the well known filament lamp in which electricity flows from one lead wire to another through the solid tungsten wire, thus heating it to incandescence, the fluorescent lamp makes use of ultra-violet energy to activate a fluorescent material coat on the inside of the tube's surface.

Below: Device testing the brightness of fluorescent powders used in the fluorescent lamps, to assure users of maximum light output throughout lamp life.



Glass tubing here emerges from a furnace in semi-liquid form.

The lamp in its present form consists of a tubular glass bulb with two external contacts at each end which are con-

nected to coiled tungsten-wire electrodes. Also within the tube is a small drop of mercury and pure argon gas at a low pressure. When electricity passes into the lamp, the mercury, vaporizes. Presently, with the aid of the argon gas, an arc forms between the electrodes at each end of the tube. Although the arc gives off a little light, most of the radiation generated is invisible ultraviolet light. The powder on the inner surface of the bulb converts this invisible radiation into visible light whose color depends upon the powder ingredients.

In common with all electric discharge apparatus, fluorescent lamps require auxiliary control equipment. The function of the starting auxiliaries is to create a momentarily high-voltage impulse in order to establish an arc between the electrodes. The auxiliary consists of two principal elements; an iron core choke coil (ballast) which limits the arc current and a starting switch which momentarily closes and then opens the electrode heating circuit. Each lamp requires a separate auxiliary, although the elements of two or more lamps may be contained in a single unit. Specifically designed ballast equipment is required for each wattage size, for each frequency, and for each voltage range.

When fluorescent lamps were first introduced a number of starting methods such as thermal switch, resonant, and magnetic switch types were utilized. Recently, how-

Hundreds of tubes, now hard and cut to length, have been stacked in readiness for assembly as lighting units.

ever, a switch known as the *glow switch* operating on the thermal principle has been manufactured. This new starting device is about 1 inch long and about 3-8" in diameter. It resembles a minature electric lamp, and contains an easily ionized gas and two bi-metallic electrodes which serve as the switch contacts. The switch is connected in series with the fluorescent lamp electrodes; when the current is turned on a glow discharge is created between the normally open switch contacts of the bi-metallic electrodes. The heat of the flow causes the contacts to close. At this point the lamp electrodes are heated to a bright red color. As the contact closes the glow discharge automatically ceases, allowing the bi-metal elements to cool and separate, opening the switch and striking the arc in the lamp. The whole operation from the time the current is applied until the arc is established requires only one to two seconds.

Power consuming apparatus of the *inductive* class such as coils and other current limiting devices have a lagging power factor. For this reason the equation for power applied to fluorescent lamp installation is: Watts=volts×amperes ×power factor. The power factor of the average fluorescent lamp itself is about 90 per cent. Due to the ballast choke, however, the power factor for the complete unit is reduced to 50 or 60 per cent. This low power factor is expensive and undesirable, hence in order to improve the power factor, a suitable condenser is connected across the choke coil. In the case of two lamps operated from ballasts housed in the same unit, the *split phase* principle is used; one of the lamps is ballasted by inductive reactance only and the other by inductance and capacitance in series.

Comparing fluorescent equipment with its predecessor, the tungsten (filament lamp), the filament lamps produced a great amount of radiant heat; fluorescent lamps produce

Finished fluorescent lighting tubes are assembled on racks for final inspection and test.

about one-fourth that produced by filament lamps for the same amount of light delivered. The fluorescent tube, for this reason, is well adapted for nearby use. Fluorescent equipment has a *low surface brightness*, making it possible to increase the comfort level of a lighting system, and

(*Please see page 22*)

Below: Light output test—one of the scores of tests by means of which the manufacturers assure users they are getting the best in quality.

NAMES

. . . *in the news*

By William R. Schmitz
Freshman in Chemical Engineering

BOB DEBS

Bob Debs is a member of Sigma Phi Delta, Sigma Tau, Pi Mu Epsilon, and corresponding secretary of Tau Beta Pi. Last year Bob was general chairman of the music committee for the music hour at the Union Building. Tall, thick-spectacled and dark haired, this remarkable personality hides behind an easy smile.

As you might suppose, music is one of Bob's hobbies. Another hobby, which you would be equally unlikely to guess, is hitch-hiking. In fact, Bob likes it so well that he hitchhiked all the way to New York and back last summer. And if you don't know why he would go that far, just remember the rumor—It was to see a certain little lady. He wouldn't tell your columnist whether she was a blonde, brunette, or a red-head, but he admits liking all three!

He tells freshmen to form two things quickly—study habits and friendships. He says that at Illinois you will meet people who will be your friends for life, and the best thing is to make as many friendships as possible.

Bob has found particular enjoyment in mathematics, physics, and English literature. As an engineering physicist

BILL

GEORGE

Bob expects to go into research and development work. He is very interested in X-rays and electronics. His laudable hope is to be able to do something of benefit to science and man.

BILL WUELLNER

Home town boy makes good! That is the story of Bill Wuellner. Bill is a resident of Urbana and lives very close to the campus. Bill thinks that he has an advantage over the other fellows in being able to stay at home. He appreciates those home-cooked meals, but wishes that he was a little more independent and did not have to account for his every move.

Bill is also an electrical engineer of some reknown. Specializing in power, Bill once came close to having an accident. He caught hold of a 220 volt wire and could not let loose. (He lived to tell us about it.) Bill is a member of Eta Kappa Nu, Phi Eta Sigma, Beta Kappa, Phalanx,

JOHN

BOB

T.N.T., Pershing Rifles, A.I.E.E., and is chairman of the forth-coming Electrical Show.

Bill is a true gentleman, scholar, and soldier. Right now, Bill's main thought is military. He is looking forward to his sojourn in the army with enthusiasm. A Cadet Captain in the Engineers, Bill puts in about ten hours a week on military subjects and drill. Although he is not looking ahead into the future too much, Bill admits that he would like after the war to have a responsible position with a good salary, a nice home, and a good wife.

He likes the same things that you and I like, including the ever popular female. He says that Illinae are a fine bunch of girls, but insists that we make "co-ed" singular. Not only is he a good tennis and golf player, but he is also a good bowler. His pet peeve is that he can never find a bowling alley open when he wants to go bowling.

JOHN FICOR

John Ficor, senior M. E., is a quiet, mild-mannered individual with a great love for engineering. Interested in engineering since his early boyhood, John began looking about for the best engineering school. Quite naturally he chose Illinois, chiefly because of the reputations of the engineering professors here.

Although John doesn't have a whole lot of spare time, he says that outside activities are vital to a college student's life. He particularly stressed that these activities should tie up with your profession some way. Some of the organizations to which he belongs are: Phi Eta Sigma, Sigma Tau, Pi Tau Sigma, Tau Beta Pi, Scabbard and Blade, and A.S.M.E. He holds the rank of Cadet Captain in the Field Artillery.

This stalwart son from Madison, Ill., has a few hobbies that he likes to pursue in his spare time: building model airplanes and reading fiction books, playing baseball and swimming. Also a music lover, especially of light opera, John's favorite piece is Andre Kostelanetz's *Begin The Beguine.*

Right now, John is interested in writing a thesis on the photo-elastic investigation of design of railway car-wheels. Principally interested in design and power, John has especially liked his T. A. M. and Design courses here at school, which may contribute to his good 4.55 scholastic average.

John likes the way the campus is laid out, but insists that the Alma Mater statue is in the wrong place. He believes that it should be in a more prominent place, and we are inclined to agree with him.

GEORGE DACEY

The greatest music lover of the E. E.'s is genial heavy-set George Dacey. George's interest in music dates back to

(*Please see page* 22)


More aluminum up there, less in new telephones —for victory!
Many materials used in telephone making are listed as "critical" for war purposes. Bell Telephone Laboratories and Western Electric have redesigned apparatus and changed manufacturing methods to employ available materials.
Take aluminum. The reduction in its use in a year's telephone output is enough to build 294 combat planes. This program has been replacing critical materials at an annual rate of 7,747,000 pounds. Though it grows steadily more difficult to maintain as shortages increase, the program helps to meet the greatest demand in history for military and civilian communication equipment.
"THOSE PLANES WILL HELP DADDY LICK 'EM!"
Western Electric
. . . is back of your Bell Telephone service

TECHNOCRACKED . . .

By Edward C. Tudor
Senior in Electrical Engineering

•

Even with a war in full swing there is still a preponderance of humor available along all the walks of life. We would like to pass along a few of the more inane items from the newspapers that we think deserve comment.

For instance, two Chicago policemen who went to the rescue of a duck, apparently frozen in Lake Michigan, fell into the icy water. The duck flew away. This bird has evidently been reading the comic strips.

"You can provide food, bedding, and shoes for a horse today for 50 cents a day."—New York Daily Mirror. —Wanna bet?

Headline: "Speed Wastes Tires." And pedestrians, too! "Wanted—Fireman. Hotel experience. Apply sober. 503 Times."—New York Times. Need we say anything!

"A whispered word in Dallas, Tex., that only black candles would be allowed in blackouts caused a run on them. One dealer sold 10,000 before the public became aware of the hoax."—St. Louis Globe-Democrat. Quick Jeeves, the gold bricks.

"Hess is where he ought to be,"—Churchill. If this be the case we hope Dante had the right idea about things down there.

"Dishwater recommended as poison antidote." No thank you, we'll put up with the arsenic.

It's a duty to drive carefully club is told." And against the law to drive any other way, in case you're interested.

76 tires stolen in city; 76 permits for new ones issued." Well, at least they're holding their own.

Then there's always some good ones from the war situation, to wit:—

Headline: "Nazis Willing to Rule the World." We'll bet that if they had half a chance they'd fight to do it.

"Goebbels tells Germany it will win or lose all." We get the impression that he's half right at that.

"Biggest gun in army on display in Chicago." Guard it well, fellows, don't let those Chicago torpedoes get hold of that thing.

"War work aided by surplus corn." At least it helps some Engineers to forget their worldly troubles.

"Another German General ailing." Better rush a surgeon, Adolph, before the guy gets well.

And along the same lines: "Soviet Ambassador in Tokyo leaving because of ill health." He'd better hurry before the Japs decide to operate.

We understand that there are so many office-holders in Washington now that the government is putting names on revolving doors. In fact, a railroad ticket agent fainted at his window the other day when a man asked for a round-trip ticket to Washington.

It is standard practice these days when entering a night club for one to hang his hat and coat on a fireplug and check the spare tire.

We know it was Talleyrand, but it might well have been "Buck" Knight, who said of coffee, "It must be pure as an angel, strong as love, black as the devil, and hot as hell."

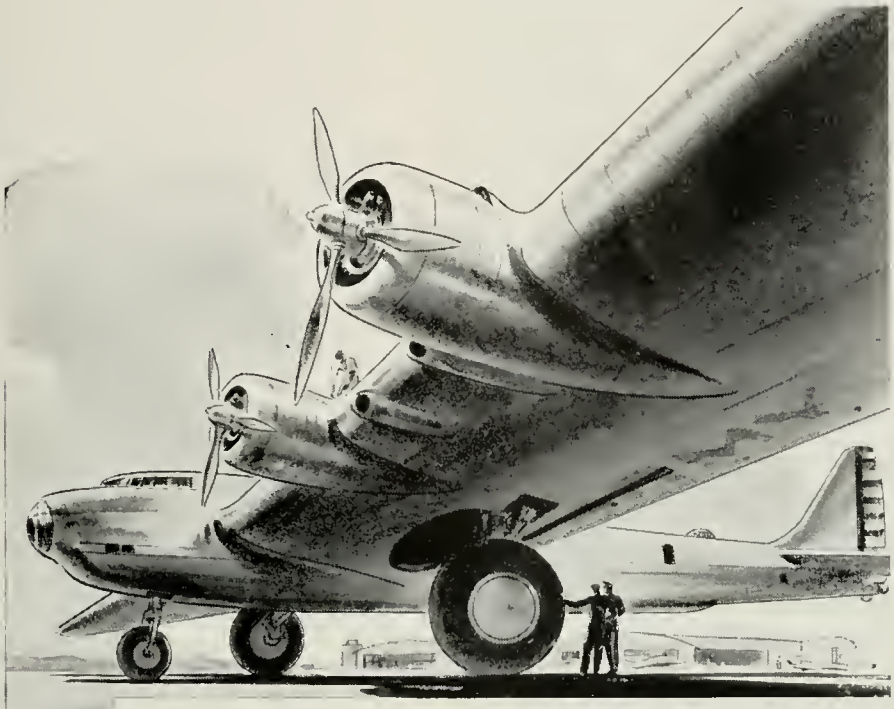
We just finished Groucho Marx's new book on income taxes, "Many Happy Returns." We're convinced that a better title would have been "Many Slap-happy Returns." The book greatly clarifies ou rquestions on the case of a befuddled fellow in Berkley, Cal., who made out his tax return then committed suicide. A tavern owner in Chicago found an easier way out. After tax auditors had billed him for $1700 he replied with the following laconic note,— "Tavern is yours, I'm going Jap hunting."

From Howard Brubaker in The New Yorker, "Many officials of the Coolidge and Hoover administrations are being pressed into the service of their country. In this crisis, our leaders are not too proud to use reclaimed Republicans."

Directions for extinguishing an incendiary bomb from the San Francisco Chronicle; "If water is applied too rapidly, an explosion is likely. Never apply water directly from a bucket. The best method is the application of water directly from a bucket." We're giving odds on the bomb.

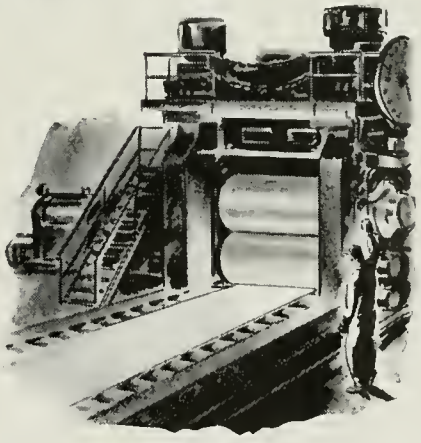
(*Please see page* 19)

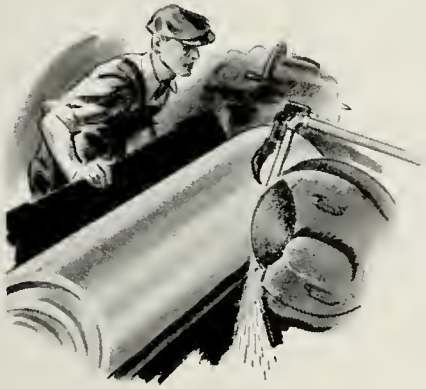
What does it take to smooth a Warbird's Feathers?



A wingspread of 212 feet ...every inch preened sleek as satin! The perfect smoothness of the metal sheathing on American warbirds like the B-19, world's mightiest bomber, isn't there for looks. It's essential to top performance. How do they get the flawless sheets of metal used to make airplanes? They're rolled out by the ton by giant steel rolls. And keeping the surfaces of these rolls ground to almost perfect accuracy and finish is another of the vital contributions of Carborundum-made wheels to America's defense.

Thousands of other products for defense and for normal needs are made by the rolling process. Plate glass for your car, steel rails, plastics, tin plate and paper are only a few. And since their surfaces can be only as perfect as the faces of the rolls that roll them, finish is highly important. Today, surface quality of rolls can be maintained to within a few millionths of an inch by the use of Carborundum-made grinding wheels.





The same skill and experience that have helped develop modern roll grinding technique will be at your disposal in any industry with which you may become associated. Whatever the use of grinding wheels or coated abrasives, Carborundum engineers are ready at all times to advise and help. The Carborundum Company, Niagara Falls, New York.

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REG. U.S. PAT. OFF.
ABRASIVE PRODUCTS

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Return of the Carbon Age

CARBON . . . one of Nature's oldest and most plentiful materials . . . is making possible some of industry's newest achievements.

In the *chemical* industry, massive black towers of carbon . . . erected in incredibly short periods of time . . . speed the delivery of vital acids. The all-carbon electrostatic precipitator . . . built of carbon from the bottom to the top of the stack . . . is now an actuality. Such towers can be erected in as little as a *week's time!* Staunchly immune to corrosion and thermal shock, they should last *indefinitely*.

Today . . . due to basic and applied research into the properties of carbon and graphite . . . it is possible to obtain these black, wonder-working materials in such a variety of forms—blocks, bricks, beams, tubes, pipes, and fittings . . . even valves and pumps . . . that almost any size or shape of structure can be built from them. For making tight joints, which give the structure uniform properties throughout, special carbon- and graphite-base cements have been developed.

Undisturbed by the torture of heat, carbon is also a "must" in the *metallurgical* industry. Carbon *cannot be melted* . . . will not soften . . . and has remarkable dimensional stability even at incandescent heat. In addition, it will not flake off and hot metal will not stick to it. That is why it is ideal for such uses as molds, cores, and plugs . . . for the lining of furnaces . . . and for sampling-dippers.

Because electric-furnace graphite conducts heat even *better than most metals,* it is becoming increasingly important in the manufacture of heat exchangers for the processing of corrosive liquids and gases.

These new uses for carbon and graphite . . . added to the almost interminable list of uses that existed before . . . make this era truly a carbon age. Your inquiries are cordially invited.

The strides made in the development of structural carbon, and in the uses of other carbon and graphite products, are greatly facilitated by the technical assistance of other Units of Union Carbide and Carbon Corporation including The Linde Air Products Company, Carbide and Carbon Chemicals Corporation, Electro Metallurgical Company, Haynes Stellite Company, and Union Carbide and Carbon Research Laboratories, Inc.—all of which collaborate with National Carbon Company in research into the properties and applications of carbon and graphite.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York, N. Y.

This all-carbon electrostatic precipitator stands 55 feet, 2 inches high.

TECHNOCRACKED

(. . . *from page* 16)

Daffynitions: Bigamist—a man who doesn't know when he's had enough.

We note that Donald Nelson is one of the three most noted Nelsons in history, the other two being Lord Nelson and half Nelson.

The only spy killed over here was sideswiped by a taxicab in New York's Times Square. And they took the driver's license away for two months!

We close with the following reproduction of some of the questions and answers supplied by Gracie Allen on a routine questionnaire filled out when she reported for her newest picture.

Professional name—"Gracie Allen" (big letters).

Travel: cities and countries, with dates—"Have travelled, but not with dates. When I have a date I'd rather park than travel, wouldn't you?"

Where educated—"Partly in school, partly listening to the Quiz Kids."

Weight—"Yes, but not where it should be."

Military record, if any—"Have one record: Sousa's 'Stars and Stripes Forever' and play it all the time."

How often attend picture shows—"Two or three times —after that a picture gets monotonous."

What would do if out of pictures—"I don't know. If you can find out what Clark Gable does out of pictures I'd be glad to help him."

Odious, huh?

We now retire to the seclusion of our padded cell to ponder that omnipresent problem during air air-raid:—whether to hide in the cellar and let the house fall in on us, or to hide in the attic and fall in with the house.

—*Courtesy General Electric Co.*

Night view of illuminated crossing.

Sodium Vapor Lights

Protect Grade Crossings

Illumination of grade crossings may greatly improve driving safety records. Sodium lights installed at several grade crossings in Faribault, Minn., have helped cut night accidents, according to records of the railroad's claim department. The lights are of the open type and utilize a 10,000-lumen sodium lamp in a horizontal position. Two lights are installed at each crossing on Division, Third, and Fourth Streets.

Prior to the sodium lighting, two night accidents occurred in three years at these crossings. The cases involved automobiles striking the sides of freight trains, and both occurred between midnight and 6 a. m. Two other accidents also occurred in this period, one happening in daylight and the other time unknown. In the three years following installation of the lights, only two accidents have happened at the crossings—both in daylight.

More than one and a third billion lamps, a new record, were sold in the United States during 1941, it is reported in the annual review of the electrical industry by Guy Bartlett. The estimated total of 1,350,000,000 included 718,-000,000 large and 610,000,0 miniature incandescent lamps, and 22,00,00 fluorescent lamps. Miniature lamps include automobile, flishlight, and similar lamps.

★ Buy U. S. Defense Bonds and Stamps ★

GERMAN AIRCRAFT RADIO . . .

Not Equal to U. S. Types

Some weeks ago a German fighter plane, a Messerschmidt 109, was shot down over the Thames estuary. Arrangements were made to have the plane shipped to the United States, enabling American engineers to examine the plane and the equipment which it carried.

The radio equipment installed in the plane included a receiver, a low-power transmitter, and a power supply unit. In general, each unit was ruggedly built. The chassis of each unit is a light weight casting, manufactured from Elektron, a special alloy replacing aluminum or steel.

The units themselves are interconnected with cable and waterproof coupling plugs. The cable is fibre covered, and unlike the shielded rubber covered cable used in American designs, humidity and abrasion could cause considerable damage. The absence of metallic shielding also makes possible the entrance of undesirable interference set up by the ignition system of the plane.

THE RECEIVER occupies 750 cubic inches and weighs thirteen pounds. It is a five tube single band radio covering a range of from 2,500 to 3,700 kilocycles. The superhetrodyne circuit employs the five tubes as follows: first RF, detector-oscillator, first IF, second detector, and audio output. Plate leads are brought out at the top of the tube. A similar circuit layout was perfected here ten years ago employing tube No. 24 (R-F Amplifier Tetrode) and No. 35 (Super-Control R-F Amplifier Pentode). No. 24 also is used as a bias detector.

The coils used in the receiver are all of the air-tuned type, and even though Germany pioneered in the development and application of iron core coils, none are used except in the second IF transformer. None of the coils are impregnated with a wax protective coating, and without doubt extreme temperatures could do them tremendous damage.

The receiver output is designed for 8,000 Ω load and the maximum power output is about 70 Milliwatts. The receiver selectivity varies from 10 microvolts at the higher frequencies to 60 microvolts at the lower end of the band. The IF frequency of the receiver is 250 kilocycles, and the first IF transformer is double tuned, while the second has but one tuned circuit.

Ceramic resistors and condensors are used extensively and each is color-coded for easy identification. All resistors and condensors are mounted on a ceramic terminal board. Ceramic components are used throughout the set much the same as we use bakelite and plastics.

THE TRANSMITTER occupies 785 cubic inches of space, and has a weight of twenty pounds. It is composed of four tubes, used as follows: straight feedback oscillator, 2 RF amplifiers, and a single tube as the modulation equipment. Provision is made for the addition of a second tube of the last type in order to supply more audio voltage to the grid of the power amplifier tube if it is subjected to high plate voltage. The frequency of the oscillator is controlled by a tuning condenser in the plate circuit and is indicated on the front panel of the unit. The output of this oscillator is fed to the two RF amplifiers which are connected in a paralleled circuit. A power supply of 275 volts, 90 cycle, AC is fed from the power supply to the transmitter and here filtered and rectified for the power supply and the bias voltages for the oscillator and speech amplifier tubes.

THE ANTENNA SYSTEM consists of a short fixed antenna and a conventional "trailing wire." The antenna system is connected with the set through a variometer and an antenna selector switch. The circuit is so arranged that when on the fixed antenna position the airplane serves as a switch is on the trailing antenna position, *both* the fixed antenna and the airplane serve as a counterpoise.

THE POWER SUPPLY occupies 500 cubic inches and weighs fifteen pounds. It consists of a motor-generator unit and filters for both output and input voltages. In addition to the 257 V. AC supply to the transmitter, the voltages supplied are: 12 V., D. C. (filament voltage), and 400 V., D. C. (plate and screen voltages).

Comparing the operating efficiency of this German radio with a modern unit installed in fighter planes of the United States, there is no doubt, of the tremendous superiority of our radio equipment; our equipment weighs as low as 40 pounds as compared with sixty pounds for German equipment. Our equipment occupies about .7 cubic ft., while German equipment occupies nearly twice that space. German equipment has a frequency range of 2,500 to 3,700 kilocycles, while American equipment has a tuneable range covering the 150 to 410 kilocycle airport band, the 1500-3900 kilocycle police band, including the 2,500 to 3,700 kilocycle aviation band, and 2 short wave bands covering 3,900 to 1800 kilocycles. While each American plane has a strong enough transmitter to maintain contact with the ground, only the commanding German plane, the transmitter in which is equipped with the second tube in the modulated circuit, has a range sufficient to maintain contact with his base. Further, American aircraft radio includes a radio-compass, an item completely absent on German equipment.

SWEEPING STEEL WITH A BROOM OF FLAME

SWEEPING over metal structures and structural parts this modern broom of fire prepares metal surfaces for a long-lasting, protective coat of paint. It is the Airco Flome Cleaning Process and removes rust and scale and dehydrates metal surfaces as it cleans. It provides a warm, dry surface conducive to a lasting paint job and assuring a faster one. Flame cleaning is the most effective method yet devised to prepare metal surfaces, new and old, for painting and repainting. Ultimate maintenance costs are lower.

Versatile is the oxyacetylene flame. It provides better and faster ways of making machines, engines, ships and tanks by shaping thin steel plates or heavy slab forgings and structures with economical ease and with a high degree of accuracy. The oxyacetylene flame hardens steel to any desired degree and depth. It softens steel, or bends it, or straightens it. It removes scale from billets, castings and forgings.

Possibly you are interested in learning more about the machines and apparatus which harness the Airco oxyacetylene flome and put it to work in so many different ways. If so, write for a copy of the pictorial review "Airco in the News" to the Airco Public Relations Department, Room 1656, 60 East 42nd Street, New York, N. Y.

AIR REDUCTION

General Offices:

60 EAST 42nd STREET, NEW YORK, N. Y.

In Texas:

Magnolia-Airco Gas Products Co.

DISTRICT OFFICES IN PRINCIPAL CITIES

ANYTHING AND EVERYTHING FOR GAS WELDING OR CUTTING AND ARC WELDING

Fluorescent Lighting
for Varied Uses

(. . . *from page* 13)

Forty-five foot-candles of comfortable, well-diffused, fluorescent troffer lighting are provided in this office.

simultaneously minimize shadows. The color quality of fluorescent equipment is much improved over filament equipment. Most important, perhaps, is efficiency. While best quality filament lamps have a life of 1000 hours, fluorescent tubes have a 2500 hour life. Best filament lamps produce about 16.5 lumens per watt power consumption, while fluorescent tubes produce about 31.08 lumens per watt power consumption. That's why manufacturers expect the annual fluorescent tube sales to reach the fifty billion mark by the end of 1943!

NAMES *in the* NEWS

(. . . *from page* 14)

his early school days. Since he has been here on the campus, George has had a prominent part in musical circles. He was a member of the cast of three operas, namely: Yeomen of the Guard, Madame Butterfly, and Manon. Possessed with a fine baritone voice, George has put in some long hours in training it. He also finds much enjoyment in collecting classical records—a welcome relief to the neighbors?).

To show that he doesn't belong in the school of music, George has a fine record in electrical engineering, at present sporting an ultra-fashionable average of 4.78. When he graduates, George expects to join Westinghouse and do some graduate work toward a degree.

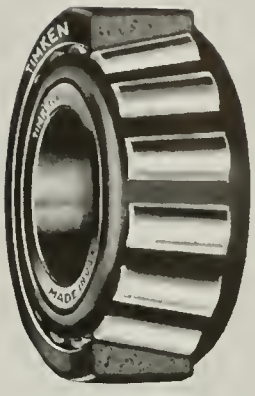
George claims Wauconda, Illinois, has his home town, and we may believe the people of Wauconda claim all one of him. His brilliance is not merely of recent origin, but extends at least back to his high school. for he graduated as the valedictorian of his class there.

During his four years here on the campus, George has managed to inadvertently gather a few honors. He is a member of Phi Eta Sigma, Sigma Tau, Tau Beta Pi, and Arepo, musical honorary society. He is treasurer of Eta Kappa Nu, is chairman of the publicity committee for the A.I.E.E., and is exhibit's manager of the 1942 Electrical Engineering show.

Skidding is the action,
When the friction is a fraction,
Of the vertical reaction,
Which results in traction.

Timken

Bearings are Keeping Wheels and Shafts Turning For Victory. They'll Keep Them Turning For Prosperity Afterwards.



Student engineers of today will have a terrific responsibility in the future; for upon their shoulders to a very great extent will fall the responsibility of developing new and better machines of all kinds to help in the reconstruction of the economic fabric of the nation.

A thorough knowledge of Timken Tapered Roller Bearings will be a valuable asset to every young engineer starting out on his career during the next two or three years—probably the most critical period our country has ever had to face.

Begin to acquire this knowledge now; write for a free copy of the Timken Reference Manual. Then you will be in position to master any bearing problem that may ever come up—no matter what combination of requirements it may involve; friction elimination; radial, thrust and combined load capacity; preservation of alignment of moving parts.

Send for your copy of the Timken Reference Manual today. Mention the name of your school when writing.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TO ASSURE VICTORY
BUY UNITED STATES
DEFENSE BONDS & STAMPS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

G-E Campus News

BLACKOUT WATCHMAN

THE problem of maintaining a night light in his place of business and at the same time complying with blackout regulations was solved by a Schenectady machine-shop owner by means of a G-E photo tube, or "electric eye." Rules required that all lights be extinguished within five minutes of an air-raid warning. That meant either hiring a watchman or turning out all lights at closing time.

The first night that the lights were turned out, the shop was broken into. So the owner, Andrew Tessier, put the "electric eye" to work. He installed the tube in an upstairs window, pointing at the nearest street light. When, during a practice blackout or raid warning, the street light is extinguished, the tube immediately turns out all lights in the shop. When the street lights go on again, so do the night lights. The "eye" provides a watchman who doesn't go to sleep on his job, and whose total cost is about two weeks' pay for an actual watchman.

MOLECULES MARCH!

WITH the increasing use of plastics and of artificial silk and rubber in defense activities, the structural qualities of the molecules that make up these materials is all-important to the scientists who are doing the research work.

Dr. Raymond M. Fuoss, of the General Electric Research Laboratory, in Schenectady, has found that some molecules wiggle like worms when an alternating electric field is applied to them. Such molecules are electrically lopsided, and when in an electric field they tend to line up, just as compass needles line up with the magnetic field of the earth.

From this tendency of the molecules to move to and fro in an electric field, scientists are able to determine how the various molecules are built. With this information, new molecules can be designed to meet specific needs. Since artificial silk and rubber and many plastics are composed of these worm-like molecules which react in an electrical field, materials of a wide variety of properties may be expected as a result of these researches.

NOT FOR WILLIE—

THE General Electric Company is proud of the variety of services it renders its customers. Nevertheless, company officials were surprised by one recent request from a woman who had seen a G-E advertisement in a magazine.

The illustration in the advertisement contained a picture of a young boy. The woman also had a boy, and her boy looked very much like the boy in the photograph.

Mother and son had only recently moved to New York. Since then, she had taken her son to a number of different barbers, but none of them had produced a haircut that suited her. And so, in desperation, she wrote to General Electric to find where the boy in the advertisement had his hair cut. It was just the type of cut she had vainly tried to get.

GENERAL ELECTRIC

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